Final Summary of ICCR Source Work Group Meeting
Long Beach, CA
July 24, 1997
Stationary Combustion Turbine Work Group

I. Purpose

The main objectives of the meeting were to finalize the Turbines Technology Workshop issues, obtain current status of each task group, and discuss HAP emissions from natural gas-fired combustors.

II. Location and Date

The meeting was organized by the US Environmental Protection Agency (EPA) and was held at the Renaissance Hotel in Long Beach, California. The meeting took place on July 24, 1997.

III. Attendees

Meeting attendees included representatives of the OAQPS Emission Standards Division, trade associations, and state agencies. A complete list of attendees, with their affiliations, is included as Attachment I.

IV. Summary of Meeting

The meeting consisted of discussions and presentations between WG members on selected issues which are listed below. The meeting also included a presentation conducted by the Database Enhancement Task Group regarding the refinement activities conducted on the gas turbine population database. The order of the meeting followed the agenda provided as Attachment II. A bullet point summary of the meeting is presented as Attachment III.

The topics of discussion included the following:

- Discussion of the outcome of the CC meeting
- Subcategorization Task Group status
- HAP Reduction Task Group status
- HAPs vs. Criteria Task Group status
- Test Methods, Monitoring, and Testing Task Group
- Discussion of risk assessment studies for combustion turbines
- Database Enhancement Task Group status
- Other issues
- Next Meeting

Discussion of the Outcome of the CC Meeting

S. Roy provided the meeting attendees with a copy of the CC meeting flash minutes. The WG briefly reviewed the decisions of the CC meeting. S. Roy indicated that an important message gained from the CC meeting is regarding presentation of information to the CC. In summary, whenever data are to be presented to the CC, the data should be made available to the CC and posted on the ICCR TTN at least one week prior to the meeting. The presented data should be provided with detailed information and good documentation so that it can be adequately assessed. Also, copies of any referenced documentation, or complete references of such documentation should be available for review during the presentation. This also applies to anyone who is going before the CC with existing information or data.

The WG decided that as a good practice of presenting information to the CC, the WG should draft all presentations with completed documentation and references and circulate this among the WG members prior to submitting the information to the CC. This will allow the WG to ensure that the information has been reviewed properly prior to its submittal to the CC.

Subcategorization Task Group Status

The Subcategorization Task Group sent out by e-mail a revised summary of potential subcategories which had been updated since the San Francisco meeting. The previously presented subcategories included three major subcategories (size, fuel, and firing temperature) and a potential subcategory (duct burners). M. Schorr indicated that through discussions with the GE R&D center, it was concluded that the turbine firing temperature as a subcategory is not practical since most turbine operators do not know the firing temperature of their machines. In addition, over the years, the firing temperature has been increasing in order to increase thermal efficiency of gas turbines. Therefore, it was decided by the WG that the firing temperature as a subcategory is not feasible for gas turbines. The remaining subcategories include the size and fuel. M. Schorr pointed out that he has not received any comments on additional possible subcategories. He stressed that these are possible subcategories, and the WG is not yet certain whether these subcategories are practical. Final subcategories will be determined subsequent to completion of the population database.

S. Roy pointed out that for MACT floor, the WG may not determine any subcategories; however, for MACT or going above the floor, the WG will have to take into consideration other factors, including cost effectiveness, feasibility, and applicability. Here, the WG may have to look at potential subcategories which were impractical for MACT floor.

S. Gieryn questioned whether subcategorization could also be based on the application/usage of the turbine. M. Schorr concurred that subcategorization based on usage will be reviewed by the

Subcategorization Task Group. Other potential subcategories discussed included duct burners and operation schedule of the turbine. G. Brown indicated that it is unknown whether HAPs emissions increase or decrease when turbine exhaust passes through a duct burner. He suggested that the task group should keep duct burners as a potential subcategory and initiate efforts in reviewing its feasibility. S. Roy will check with J. Eddinger of the Boilers WG whether duct burners are covered by the recently proposed NOx revisions for boilers, and will forward his findings to WG members by e-mail.

J. Klein questioned the justifications for excluding the operation schedule (hrs/yr) as a potential subcategory. M. Schorr responded that the operation schedule of the unit is more applicable as a threshold than a subcategory. Typically, units with short annual operation schedule will be excluded as exempted sources based on cost effectiveness issues.

As a guidance criteria, the WG concurred that subcategorization should include a set of units which have something adequately unique or used in a unique fashion to grant them a subcategory. The WG concluded this discussion by stressing that this is a continuing topic and that they should look at all possible subcategories for gas turbines.

S. Roy will solicit detailed information from EPA's OGC regarding delisting of a source category and subcategory.

HAP Reduction Task Group Status

The HAP Reduction Task Group initiated their discussion by stating that turbine operating practices were determined unfeasible for use as potential MACT standards due to their complexities. There may however be a specific practice for a certain type/model turbine which may be practical to impose in a standard. M. Schorr indicated that there may be some subtle ways to handle work practices. By not imposing work practices, for example, the regulation can specify a certain emission level which will not be achievable without conducting good operating practices. S. Gieryn disagreed with M. Schorr's suggestion by pointing out that the operator may perform maintenance on their units just prior to the scheduled tests.

J. Klein stated that the manufacturer is not always the best source for specifying good operating practices. In some cases, the user may extend the periods between maintenance based on the application type of their units. Also, the manufacturer may recommend more frequent maintenance schedules due to economic reasons. M. Schorr indicated that different industries perform different maintenance schedules. Industries which use turbines as backup units may perform more frequent maintenance on their machines than others. He also indicated that some industries have their own maintenance schedules which may be different than what the manufacturer suggests.

The WG decided not to close the issue of the potential for including the turbine operating practices in the standard.

Other topics discussed by the HAP Reduction Task Group included duct burners and CO as a surrogate to HAPs. S. Allen presented the names of three presenters who have shown an interest for conducting presentations regarding duct burners at the next WG meeting. These presenters are Rick Fiorenza of Coen Company, Inc., Greg Horne of John Zink Company, and Bill Strohecker of Forney. Each has agreed to present a half to one hour presentation to the WG.

As for CO as a potential surrogate for HAPs emissions, the WG discussed the report presented by Catalytica, which indicated that CO is not a good surrogate for HAPs emissions. M. Schorr stressed that the GE R&D Center disagrees with Catalytica's conclusion. He will be providing a writeup for the WG regarding this issue. He stressed that it is known that unburned hydrocarbons are produced as a result of incomplete combustion and that they are synthesized within the combustion chamber; therefore, CO and hydrocarbons are not completely destroyed as the Catalytic paper indicates. Therefore, it is possible that CO can be a surrogate to HAPs. S. Roy indicated that it would be beneficial to the WG to request from Catalytica the references used for the basis of their study. This will allow the WG to review these sources for their applicability and interpretation. In general, WG members indicated that CO and unburned hydrocarbons are surrogates for hydrocarbon HAPs. The correlation level depends on the combustor type and design considerations.

HAPs vs. Criteria Task Group Status

C. Chang indicated that no data have been gathered on the HAP emissions vs. criteria emissions issue. He is expecting that some information will be presented during the technology workshop which will provide the Task Group some leads in determining the relationship of HAP vs. criteria emissions. M. Schorr indicated that this is similar to the issue of CO as a surrogate to HAPs. The Task Group may be able to use the writeup by GE R&D center for identifying the relationship between HAPs and criteria emissions. M. Schorr will forward the writeup by GE's R&D Center in reference to C. Solt's paper regarding CO as a surrogate for HAPs. Rolls Royce indicated that of units with low emission levels of NOx and CO, if the CO is non-measurable (in the ppm range) then hydrocarbons and HAPs will be non-measurable. For new designs, CO levels are expected to be very low, reflecting very low HAP emissions. J. Willis of Rolls-Royce and B. Lott of GRI made reference to materials which they have and which can be used to identify the relationship between HAPs and criteria emissions. They volunteered to provide this information to the WG. R. Muller indicated he also has data reflecting the effect of SCR Catalyst on hydrocarbon emissions which he will present this information to the Task Group. J. Klein will solicit API's response regarding CO as a surrogate for HAPs.

Test Methods, Monitoring, and Testing Task Group

S. Roy presented to the WG a summary report of the potential list of HAPs to be measured during emission testing for gas turbines. This report is included as Attachment III. S. Roy indicated that the ICCR Testing and Monitoring Protocol Work Group (TMPWG) drafted a recommended list of HAPs and test methods for natural-gas fired turbines and are in the process of reviewing the list of pollutants from No. 2 fuel oil-fired units. The TMPWG may not be able to identify potential HAPs from other type of fuels. S. Roy stressed the idea that the WG should recommend testing for the most comprehensive list of pollutants regardless of the fuel type. He also stressed that criteria pollutants should be tested concurrently with the HAPs. Details must be provided to justify the reasons for inclusion or exclusion of any pollutant referenced on the list. In addition, the Task Group may need to present justification for excluding certain HAPs from the suggested list. One idea presented by S. Roy is to conduct 3 to 4 pre-screening emission tests for the comprehensive list of pollutants and then narrow that list for the subsequent tests to include only the pollutants detected during the pre-screening emission tests. Another idea presented by M. Schorr is to keep the list of pollutants for which to test flexible, and incorporate certain measures in the testing protocol which will allow the addition or deletion of certain HAPs from the list. For example, if prior to testing, a fuel analysis is performed showing no chlorine levels in the fuel, then the test will not include dioxin emission measurements. The preliminary goal of the Task Group is to have the list of pollutants for which to test completed by the CC's September meeting. The WG will review the draft recommendations for pollutants for which to test and provide comments to S. Roy by August 15, 1997.

Discussion of Risk Assessment Studies for Combustion Turbines

A presentation was made by Leonard Levin of EPRI, entitled "Risk Results for Combustion Turbines Burning Natural Gas or Kerosene." It is included as Attachment V. The risk assessment that EPRI conducted on utility turbines uses actual operating data from direct reports to EPRI by the utility. This risk assessment was conducted on utility turbines run at low usage rates. In the cases reported, capacity factors were between 2% and 15%. This was assumed to be a time-based capacity factor (i.e., full load for 2% of the time), rather than reduced load for longer than 2% of the time. Concentrations, exposures and risks were calculated using long-term average meteorology for the sites in question.

The source of metals for natural gas-fired units are still unknown, but even if these concentrations were estimated high, the risk assessment study resulted in risks that were less than 10^{-6}. S. Roy indicated that EPA must review the study prior to approving it. He pointed out that a risk assessment can be conducted with conservative emission assumptions to determine a potential worst case scenario. This can be used as a starting point for risk assessment.

C. Chang will contact the South Coast AQMD for the AB 2588 risk assessment study for combustion turbines.

S. Roy will contact C. Solt regarding the status of the risk assessment study that was to be conducted by the industry.

Database Enhancement Task Group Status

G. Adams summarized his activities and status in reviewing the population and emissions data gathered in the ICCR CT databases. For comparison with information in the Population Database, C. Chang, S. Allen, A.J. Cherian, and G. Brown submitted summaries of the gas turbine parameters for turbines operated at their sites (make, model, capacity, fuel type, etc.) The gas transmission industry has not responded to G. Adams request for data verification. The process of population information validation has proven to be very slow and unfruitful. G. Adams suggested that the Database Enhancement Task Group finish compiling the submitted information and conclude this effort of information validation. The WG concurred with this suggestion.

B. Richani conducted a presentation on the population database enhancement/refinement activities and sources of additional inventory information for gas turbines. The presentation is included as Attachment VI.

G. Adams concluded the Database Task Group's status report by reviewing the source test reports summary which he compiled from the WG members. He identified the reports designated as "incomplete". He will be compiling a summary of the reasons these test reports were found incomplete. He also indicated that he is aware of additional test reports for HAP emissions from turbines from California air basins which are not included in the EPA ICCR CT Emission Database. He will attempt to gather these reports and provide them to S. Roy for inclusion in the Emissions Database. B. Richani will attempt to complete, to the extent possible, the missing information from the gathered HAP test reports by contacting the sites directly in an effort to make these test reports useable.

Other Issues

The WG formed a task group to conduct a screening analysis for the MACT floor determination. This task group includes T. Guth, S. Roy, D. Furstenwerth, M. Schorr, C. Chang, and A.J. Cherian.

The WG concurred to concentrate on developing a MACT standard first, and that the review of the NSPS was a lower priority at this time.

The WG will have a teleconference in 2 to 3 weeks to discuss pollution prevention issues as they relate to combustion turbines. S. Roy will put together a goal statement for the upcoming pollution

prevention teleconference and will schedule the teleconference within the next 3 weeks.

S. Gieryn, D. Furstenwerth, P. Chu of EPRI and B. Lott of GRI will assist S. Roy in obtaining information to decide whether dioxin, mercury and metals including chromium, should be tested for combustion turbine emissions. This group will coordinate with other ICCR WGs who are also looking into this issue.

WG members will review the cost model posted by the TMPWG regarding test methods.

Next Meeting

The next WG meeting will be a teleconference on August 27, 1997 from 1 to 3 p.m. EST. The potential agenda items will include a review and consensus of a list of pollutants for which to test, a status report from the MACT Floor Screening Task Group, the status of presenting information regarding duct burners, the calculation procedures for the turbine capacity conversion, and a status report on the potential for dioxin and mercury emissions from turbines.

The meeting adjourned at 5:30 pm.

These minutes represent an accurate description of matters discussed and conclusions reached and include a copy of all reports received, issued, or approved at the July 24, 1997 meeting of the Stationary Combustion Turbine Work Group.

Sims Roy

ATTACHMENT I

LIST OF ATTENDEES

Stationary Combustion Turbine Work Group Meeting
July 24, 1997
List of Attendees

Sims Roy	EPA OAQPS Emissions Standards Division
Greg Adams	Los Angeles County Sanitation District
Sam Allen	Dow Chemical Company
Adriane Borgias	Pacific Gas Transmission Company
Gordon Brown	Exxon Chemical Company
Charles Chang	LA Dept. Of Water and Power
A. J. Cherian	Pacific Gas Transmission Company
Derek Furstenwerth	Houston Lighting and Power Company
Sam Gieryn	
Ted Guth	Permitting Regulatory Affairs Consultant
Peter Hill	US Naval Facilities Engineering Svc. Center
John Klein	ARCO Alaska, Inc.
Raimund Muller	Siemens Power Corporation
Marvin Schorr	Power Systems Engineering Department
Jerry Napierala	Solar Turbines
Chuck Keffer	
Paul Chu	EPRI
Leonard Levin	
Ralph Roberson	
David Yee	
Jeff Willis	Rolls Royce
Stan Coerr	Coerr Environmental
Bob Lott	Gas Research Institute
Jim McCarthy	

ATTACHMENT II

MEETING AGENDA

Agenda
Stationary Combustion Turbine Work Group
July 24 WG Meeting
Long Beach, CA

8:30 - 8:40	Welcome (S. Roy)
8:40 - 9:00	Outcome of the CC Meeting (S. Roy)
9:00 - 9:30	Technology Workshop (J. Klein) - Last Minute Issues/Preparations
9:30 - 10:30	Database Enhancement Task Group (G. Adams, B. Richani) - Status of gathering and verification of turbines information of WG members and their affiliation(s) - Status of compiling the source test reports review forms - Data gaps identification for emissions and population - Status of Refining the Population Database
10:30 - 10:45	BREAK
10:45 - 11:20	Subcategories Task Group (M. Schorr) - Status - Subcategorization Memo
11:20 - 12:00	HAP Reduction Task Group (J. Klein) - Status - Duct Burners as Potential HAP Control Technologies - Possibility of a second technology work shop
12:00 - 1:15	LUNCH
1:15 - 1:45	HAP vs. Criteria Task Group (C. Chang) - Status
1:45 - 2:30	Test Methods, Monitoring, and Testing Task Group (S. Roy) - Information Requested from the TMPWG - Status
2:30 -3:15	Risk Assessment Studies (S. Roy, C. Solt, EPRI) - Summary/status/discussions
3:15 - 3:30	BREAK
3:30 - 4:15	Gathering of Additional Population Information (B. Richani) - 1992 Section 114, comparisons, results - Trade associations inventory campaigns (AGA, API,& INGAA) - DOD data - DOE (utility sources information) - Louisiana data - Manufacturers Information (GE and Solar)
4:15 - 4:45	Planning Task Group (S. Roy, M. Schorr) - WG status - Future activities/next steps
4:45 - 5:15	Developing Revised NSPS for Combustion Turbines (Sims Roy, Marvin Schorr)
5:15 - 5:30	Compose the meeting flash minutes and develop agenda items and schedule for the next work group meeting

5:30 ADJOURN

ATTACHMENT III

BULLET POINT SUMMARY

Summary of ICCR Source Workgroup
Stationary Combustion Turbine Workgroup
July 24, 1997

Decisions:

- S. Roy will be the point of contact for providing copies of the presentations and handout material given during the turbine technology workshop after the initial copies have been supplied to attendees.
- The WG indicated that "Firing Temperature" is not feasible as a possible subcategory due to the potential changes in turbine operating conditions as a result of unrecorded refurbishing activities.
- Potential subcategories may be based on application, fuel type, and size. Subcategorization is still incomplete and no possible subcategories have been eliminated. Potential subcategories will be decided subsequent to completion of the verified database.
- The WG will keep operating practices open as a potential requirement in the standard.
- The WG will present to the CC the "List of Pollutants for Turbines" during the CC September meeting.
- The Database Enhancement Task Group will finish conducting the voluntary information validation as soon as possible.
- The WG formed a task group to conduct a screening analysis for the MACT Floor determination. This task group includes T. Guth, S. Roy, D. Furstenwerth, M. Schorr, C. Chang, and A. J. Cherian.
- The WG concurred to concentrate on developing MACT Standard first and that the review of the NSPS was a lower priority at this time.
- The WG will have a teleconference in 2 to 3 weeks to discuss pollution prevention issues as they relate to combustion turbines.

Next Meeting:

- The next WG meeting will be a teleconference meeting on August 27, 1997, from 1 to 3 PM EST.
- The potential agenda items will include the following:
  1- Review and get consensus on the list of pollutants to test for,
  2- Status report form the MACT Floor screening task group,
  3- Discuss the status of presenting information regarding duct burners,
  4- Discuss the calculation procedures for turbine capacity conversion, and
  5- Status report on the potential of dioxin and mercury emissions from turbines.

Action Items:

- The WG will review the draft recommendations for pollutants to test for from combustion turbines and provide comments to S. Roy by August 15, 1997.
- S. Roy will contact C. Solt regarding de-listing based on the results of the risk assessment study conducted by Catalytica.
- M. Schorr will forward the write-up by GE's R&D Center in reference to C. Solt's paper regarding CO as a surrogate to HAPs.
- J. Klein will solicit API's response regarding CO as a surrogate to HAPs.
- S. Roy will put together a goal statement for the upcoming pollution prevention teleconference and will schedule the teleconference within the next 3 weeks.
- S. Roy will discuss with J. Eddinger of the boilers WG whether duct burners are covered by the recently proposed NOx revisions for boilers. S. Roy will forward his findings to WG members by e-mail.
- S. Gieryn, D. Furstenwerth, P. Chu of EPRI, and B. Lott of GRI will assist S. Roy in obtaining information to decide whether dioxin and mercury should be tested for from combustion turbine emissions. This group will coordinate with other ICCR WGs who are looking into the same issue.
- WG members will review the cost model posted by the TMPWG regarding test

methods.

- B. Richani will attempt to complete, to the extent possible, the missing information from the gathered HAP test reports by contacting the site directly in an effort to make these reports usable.
- G. Adams will contact California air basins to gather additional source test reports for HAP emissions from turbines.
- S. Roy will solicit detailed information from EPA’s OGC regarding de-listing of a source category and subcategory.
- C. Chang will contact the South Coast AQMD for the AB 2588 risk assessment study for combustion turbines.

ATTACHMENT IV

TESTING AND MONITORING TASK GROUP REPORT

SUMMARY REPORT

STATIONARY GAS TURBINES WORK GROUP

SHORT LIST OF HAZARDOUS AIR POLLUTANTS

Prepared By
The CT Testing and Monitoring Task Group

JULY, 1997

RECOMMENDATIONS

In support of the ICCR, the Stationary Gas Turbine (CT) Testing and Monitoring Task Group has drafted a short list of HAPs from Stationary Gas Turbines for future emissions testing. Separate tables are presented based on fuel type. Included in these tables are the recommended test methods for the listed pollutants. All lists should be considered in draft form. This information was gathered from several sources, including source test reports gathered by EPA, recommendation from the ICCR Testing and Monitoring Work Group, and a technical report for gas-fired turbines presented by the Electric Power Research Institute (EPRI) and published by the Gas Research Institute (GRI).

The CT Testing and Monitoring Task Group also recommends measuring criteria emissions simultaneously with the HAP emissions. This is recommended for all fuel types. The recommended criteria pollutants for testing include Carbon Monoxide (CO), Nitrogen Oxides (NOx), Sulfur Dioxide (SO2), and Total Volatile Organic Compounds (VOCs). Measurement of these pollutants can be performed using EPA methods 10, 20, 6C, and 25A, respectively

TABLE 1. Short List of HAPs for Stationary Gas Turbines
Natural Gas-Fired Units

Pollutant	EPA Gathered Source Tests	ICCR TMWG	EPRI	Test Method(s) Used
Acetaldehyde	✓	✓		CARB 430 / FTIR
Acrolein	✓	✓		CARB 430 / FTIR
Arsenic	✓			CARB 423
Benzene	✓	✓	✓	CARB 422 / TO-14
Biphenyl		✓		CARB 429
Chromium Compounds			✓	EPA Draft 29
Ethylbenzene	✓	✓		CARB 422 / TO-14
Formaldehyde	✓	✓	✓	CARB 430 / FTIR
Hexane		✓		EPA TO-14
Lead			✓	EPA Draft 29
Manganese			✓	EPA Draft 29
Mercury	✓			CARB 101 /101A
Naphthalene	✓			CARB 429
Nickel			✓	EPA Draft 29
Pollutant	**EPA Gathered Source Tests**	**ICCR TMWG**	**EPRI**	**Test Method(s) Used**

PAH	✓		✓	CARB 429
Phenol		✓		CARB 429(m)
Styrene		✓		EPA TO-14
Toluene	✓	✓	✓	CARB 422 / TO-14
Xylene	✓	✓		CARB 422

TABLE 2. Short List of HAPs for Stationary Gas Turbines Diesel-Fired Units

Pollutant	**EPA Gathered Source Tests**	**Test Method(s) Used**
Arsenic	✓	CARB 436
Benzene	✓	CARB 422
Beryllium	✓	CARB 436
Cadmium	✓	CARB 424
Chromium Compounds	✓	CARB 425
Formaldehyde	✓	CARB 430
Lead	✓	CARB 436
Manganese	✓	CARB 436
Mercury	✓	CARB 436
Naphthalene	✓	CARB 429
Nickel	✓	CARB 436
PAH	✓	CARB 430

TABLE 3. Short List of HAPs for Stationary Gas Turbines Refinery Gas-Fired Units

Pollutant	EPA Gathered Source Tests	Test Method(s) Used
Cadmium	✓	CARB 424
Chromium Compounds	✓	CARB 425
Manganese	✓	CARB 436
Mercury	✓	CARB 436
Naphthalene	✓	CARB 429
Nickel	✓	CARB 436
PAH	✓	CARB 429

TABLE 4. Short List of HAPs for Stationary Gas Turbines Field Gas-Fired Units

Pollutant	EPA Gathered Source Tests	Test Method(s) Used
Formaldehyde	✓	CARB 430

BACKGROUND

The short list of HAPs for combustion turbines is compiled from three sources of emission information. These sources include the HAP emissions source test reports gathered by EPA from state and local agencies (primarily California), the recommendations presented by the ICCR Testing and Monitoring Work Group, and an emission study conducted by EPRI. A brief description of the information presented by each source is provided below.

I- Source Test Reports Gathered by EPA

EPA gathered a total of 28 source test reports for HAP emissions from Stationary Gas Turbines. Some of these test reports were a compilation of testing campaigns conducted by trade associations or local regulatory agencies. The gathered test reports contain emission test data for a total of 50 gas turbines. Emissions data were gathered for several fuel types, including natural gas, diesel fuel, refinery gas, and field gas.

Two criteria were reviewed in composing the short list of HAPs from the gathered source test reports. The first criteria identified the HAP pollutants that account for 99 percent of the total mass emissions in any source test report, and the second criteria identifies the HAP pollutants which resulted in stack emissions higher than the corresponding test method detection limit. These criteria were conducted for each of the fuel types referenced in the test reports. The lists of HAPs identified from the gathered source test reports is presented in Tables 5 through 8.

TABLE 5. List of HAPs Gathered from Source Test Reports
Natural Gas-Fired Turbines

Pollutant	Criteria I (99% of mass emissions)	Criteria II (measured above DL)	Test Method(s) Used
Acetaldehyde	✓	✓	CARB 430
Acrolein	✓	✓	CARB 430
Arsenic	✓	✓	CARB 423
Benzene	✓	✓	CARB 422
Ethylbenzene	✓	✓	CARB 422
Formaldehyde	✓	✓	CARB 430
Mercury	✓	✓	CARB 101 /101A
Naphthalene	✓	✓	CARB 429
PAH	✓	✓	CARB 429
Toluene	✓	✓	CARB 422
Xylene	✓	✓	CARB 422

TABLE 6. List of HAPs Gathered from Source Test Reports
Diesel-Fired Turbines

Pollutant	Criteria I (99% of mass emissions)	Criteria II (measured above DL)	Test Method(s) Used
Arsenic		✓	CARB 436
Benzene	✓	✓	CARB 422
Beryllium		✓	CARB 436
Cadmium		✓	CARB 424
Chromium Compounds	✓	✓	CARB 425
Formaldehyde	✓	✓	CARB 430
Lead	✓	✓	CARB 436
Manganese	✓	✓	CARB 436
Mercury		✓	CARB 436
Naphthalene	✓	✓	CARB 429
Nickel	✓	✓	CARB 436
PAH	✓	✓	CARB 430

TABLE 7. List of HAPs Gathered from Source Test Reports
Refinery Gas-Fired Turbines

Pollutant	Criteria I (99% of mass emissions)	Criteria II (measured above DL)	Test Method(s) Used
Cadmium		✓	CARB 424
Chromium Compounds	✓	✓	CARB 425
Manganese	✓	✓	CARB 436
Mercury	✓	✓	CARB 436
Naphthalene	✓	✓	CARB 429
Nickel	✓	✓	CARB 436
PAH	✓	✓	CARB 429

TABLE 8. List of HAPs Gathered from Source Test Reports
Field Gas-Fired Turbines

Pollutant	Criteria I (99% of mass emissions)	Criteria II (measured above DL)	Test Method(s) Used
Formaldehyde	✓	✓	CARB 430

II. ICCR Testing and Monitoring Work Group

The ICCR Testing and Monitoring Work Group (TMWG) presented a short list of HAP pollutants for natural gas-fired turbines. No recommendations were provided by the TMWG for turbines using other types of fuel; however, the TMWG indicated that similar lists of HAPs can be assembled for other fuels if requested by the Gas Turbine WG. The TMWG also noted that their short lists of HAPs for turbines using fuels other than natural gas would most likely be similar to the ones compiled by EPA.

The short list of HAPs and corresponding test methods recommended by the TMWG for natural gas-fired turbines is presented in Table 9. Contrary to the list presented by EPA, metallic HAPs are excluded from the TMWG recommended list. The explanation provided by the TMWG for excluding such HAPs indicates that these compounds are not emitted in significant quantities from the source.

TABLE 9. List of HAPs Recommended by the ICCR TMWG
Natural Gas-Fired Turbines

Pollutant	Applicable Test Method
Acetaldehyde	FTIR
Acrolein	FTIR
Benzene	EPA TO-14
Biphenyl	CARB 429
Ethylbenzene	EPA TO-14
Formaldehyde	CARB 430 / FTIR
Hexane	EPA TO-14
Methanol	EPA TO-14 / FTIR
Phenol	EPA 0010 / CARB 429(m)
Styrene	EPA TO-14
Toluene	EPA TO-14 / EPA 0030 / CARB 422
Xylenes (o, m, & p)	EPA 0030 / 18 / CARB 422

III Electric Power Research Institute (EPRI)

The Electric Power Research Institute (EPRI) conducted emission measurement tests on two

gas turbines. Both turbines were fired by natural gas. The list of HAPs measured from these turbines includes metals, semi-volatile organic compounds, and hydrocarbons. These emissions were presented in three categories; 1) emissions measured at more than twice the field blank levels, 2) emissions measured at less than twice the field blank levels, and 3) emissions that were not detected by the analytical method. These emissions are presented in Table 10. A fuel analysis was also conducted for each unit tested for direct comparison with the stack emissions.

It is noted in the EPRI study that the metals emission from both units were very similar. The possible sources of these emissions were related to the fuel, the combustion air, and the unit surfaces. None of the metals were detected in the fuel analysis; however, except for arsenic and mercury, the fuel analysis detection limits were higher than the stack gas analysis detection limits. Therefore, it could not be determined if the metallic emissions originated from the fuel. Similarly, ambient air samples were collected at the sites of both turbines and analyzed for the trace metals. For both sites, the ambient air trace analysis indicated that the ambient air was not a contributor to the metals emissions.

As indicated above, the last potential source of the metals emissions form the turbines is the unit surfaces. The turbine unit surfaces are a potential source of chromium and nickel due to their presence in stainless steel. Both of these metals were detected above the field blank levels for both turbines.

The EPRI report included a risk assessment study for the measured HAP emissions from the tested turbines. It is concluded that the emissions of HAPs from the gas-fired turbines will not pose significant carcinogenic or non-carcinogenic public health risk.

TABLE 10. List of HAPs Gathered from EPRI Natural Gas-Fired Turbines

Pollutant	Not Detected	Detected <2xFB	Detected >2xFB	Test Method
Arsenic		✓		EPA Draft 29
Benzene			✓	CARB 410A EPA TO 14
Beryllium	✓			EPA Draft 29
Cadmium	✓			EPA Draft 29
Chromium Compounds			✓	EPA Draft 29
Cobalt		✓		EPA Draft 29
Formaldehyde			✓	CARB 430
Pollutant	**Not Detected**	**Detected <2xFB**	**Detected >2xFB**	**Test Method**
Lead			✓	EPA Draft 29
Manganese			✓	EPA Draft 29

Mercury		✓		EPA Draft 29
Naphthalene		✓		CARB 429
Nickel			✓	EPA Draft 29
PAH			✓	CARB 429
PCB	✓			CARB 428
Phosphorus(1)		✓		EPA Draft 29
Selenium	✓			EPA Draft 29
Toluene			✓	CARB 410A EPA TO-14

(1)Most likely as phosphate which is not a HAP.

ATTACHMENT V

EPRI RISK ASSESSMENT STUDY PRESENTATION

Risk Results for Combustion Turbines Burning Natural Gas or Kerosene

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Stationary Combustion Turbine Work Group

Long Beach, Calif.

July 24, 1997

2 Combustion Turbines Tested

EPRI, GRI, + several utilities

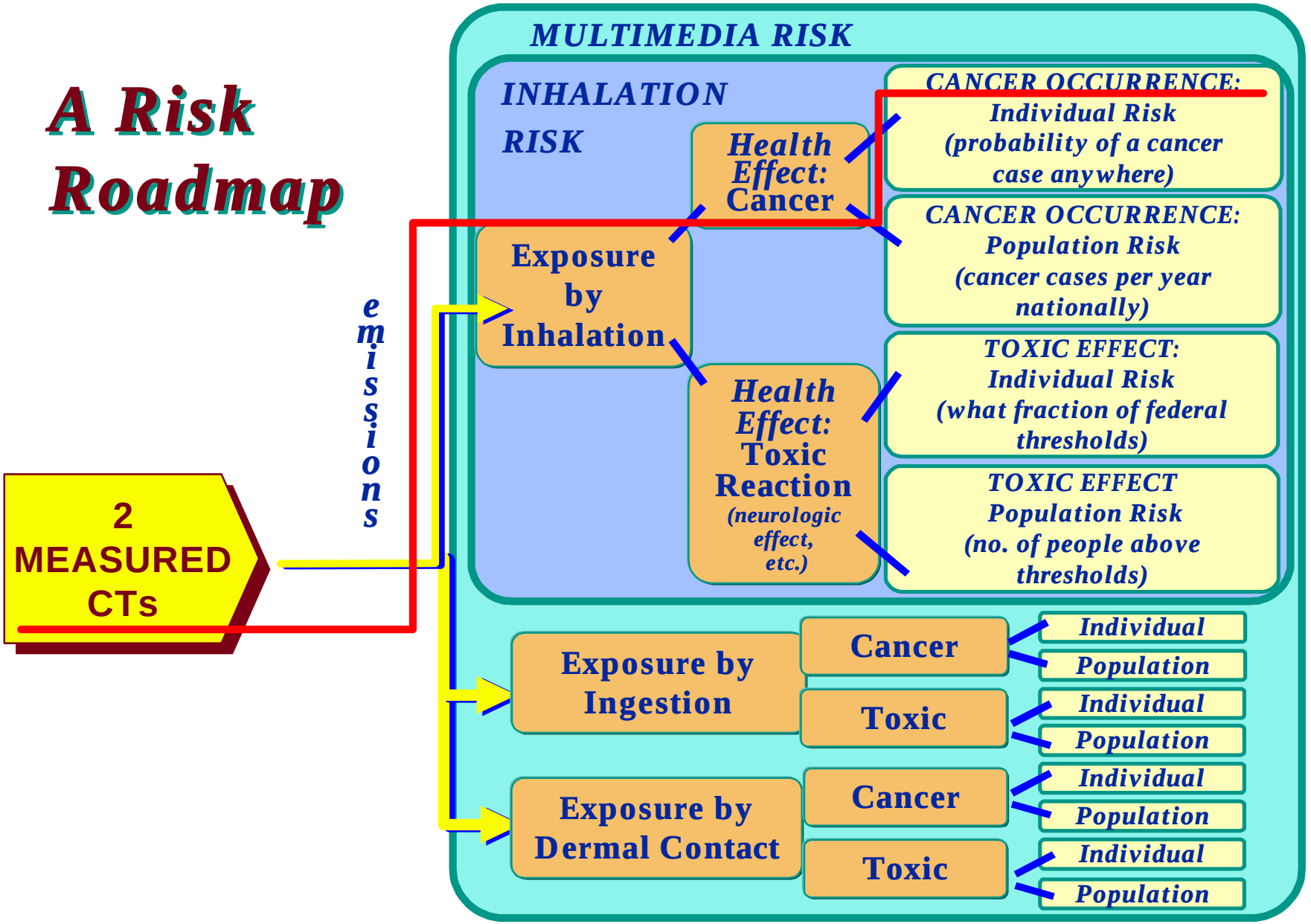
- Westinghouse 501AA
  - Gas-fired simple cycle
  - No NOx control
  - 53 MW summer
  - 73 MW winter

- GE Frame 7
  - Gas-fired simple cycle
  - Water injection for NOx control
  - 143 MW

Emissions Summary

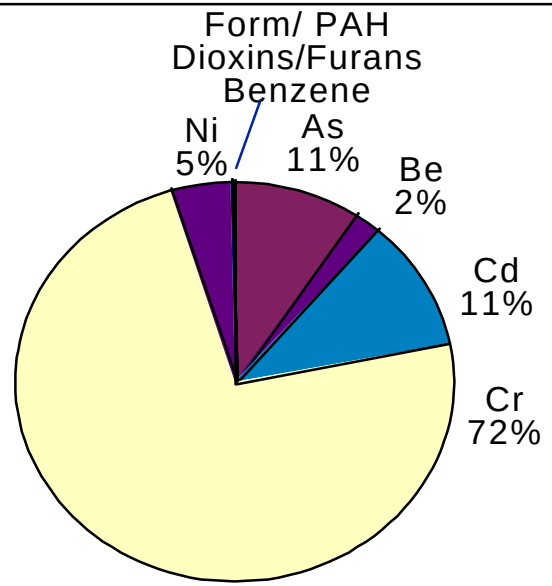
- Trace metals
  - 6 metals detected at least one site
  - Near blank levels (1 - 6 #/10^{12} Btu)
- VOCs, aldehydes
- Generally low at full load
  - 1 - 90 #/10^{12} Btu
- Increased at minimum loads
  - 10 - 7500 #/10^{12} Btu

A Risk Roadmap



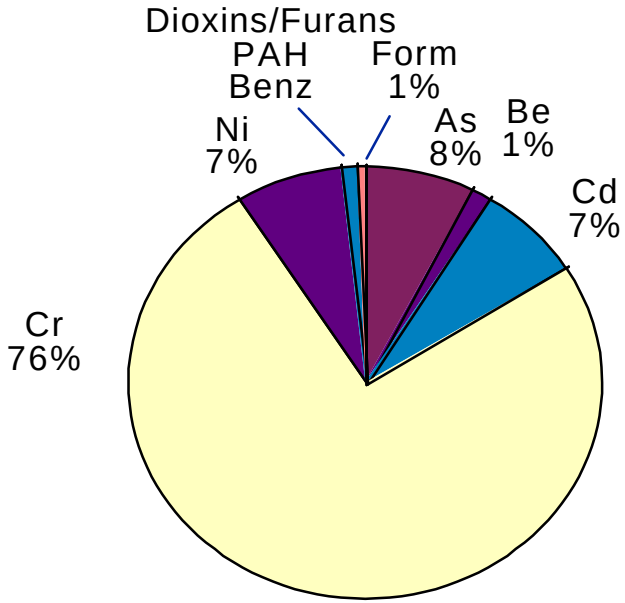
Utility A

Combustion Turbine, Distillate Oil (32)



MEI Cancer Risk: 6.2 x10^{-8}

Combustion Turbine, Gas (16)

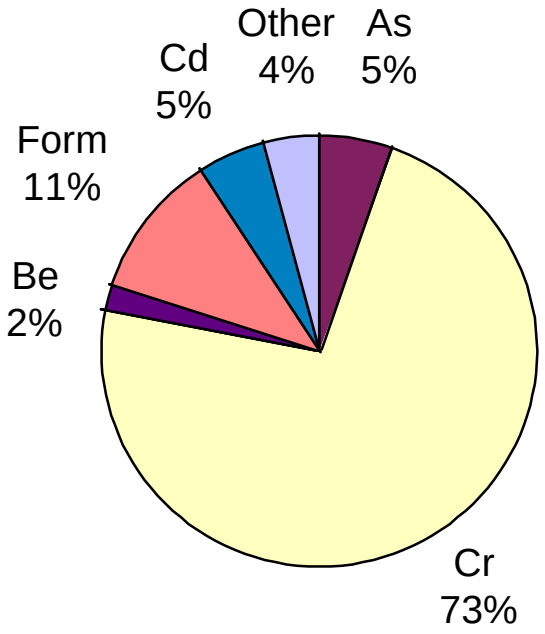


MEI Cancer Risk: 1.1x10^{-8}

	CT (distillate)	Residual Oil Boiler
Fuel use (x 10^3 lb)	23,000	592,000
Stack height (ft)	52	300 +
MEI Risk	6 x 10^{-8}	3 x 10^{-6}
Capacity factor	2%	20%

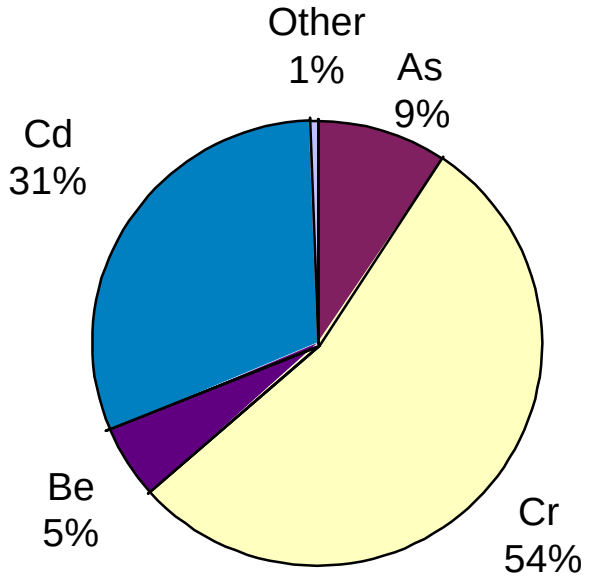
Utility B

Combustion Turbine, Gas



MEI Cancer Risk: 1.3×10^{-9}

Combustion Turbine, Kerosene



MEI Cancer Risk: 2.5×10^{-9}

ATTACHMENT VI

EPA INVENTORY DATABASE PRESENTATION

Stationary Gas Turbine Work Group

Population Database - Refinement

July 24, 1997

CT Population Database

- Refinement Activities
  - Goals:

    Clean up the population database

    Summarize and review the gathered information

  - Products:

    Database more applicable to turbines

    Simplified population database

  - Schedule:

    July to September, '97

    (All Refining Activities should be <u>reproducible</u> for documentation purposes)

CT Population Database

- Completed Refinement Activities
  - Identified Non-turbine units

    Incorporated a reference code to identify the appropriate ICCR Source Category for each record

    (X-non ICCR; B- Boiler; I- Incinerators; P-Heaters; T- CT; and R- turbines)

    Forwarded non-turbines to appropriate ICCR Source Work Groups

    (A total of 197 records were identified as non-turbines)

CT Population Database

- Completed Refinement Activities (Cont.)
  - Extracted turbine information from text fields
    (Make, Model, Size & units, Fuel Type, and # Units)
    "Combustor Description" - 2,503 records
    "Fuel Type" - 2,104 records
  - Assigned SCCs to turbines with incomplete SCCs
    Used the text fields to identify the unit - 59 records
  - Identified turbine's fuel type from the SCC Code - 4,502 rec.
    Criteria: Fuel Type > Combustor Description > SCC

    (All extracted/updated information are compiled in separate tables mergable with Version 2)

CT Population Database

- Completed Refinement Activities (Cont.)
  - Developed “Short List of Fields”

    Data integrity:

    Almost all activities are in electronic form

    Manual activities are referenced in “Memos” to the files

    Incorporated a source code for each piece of information

  - Submitted extracted turbine Make and Model information to WG members

    (~40% of the records have Make and Model or Capacity information)

CT Population Database

- Results:
  - Total Number of turbines: 5,331

CT Population Database

- Next Steps:
  - Complete the Make and Model table for turbines
  - Compare/update with other sources of information
    1992 Section 114 Data
    GE
    SOLAR
    Ventura County
    DOD

  - Update with Louisiana and New York Data

CT Population Database

- Next Steps (Cont.):
  - Convert turbine size to a standard unit

    Turbine size units provided in energy input units or power output units

    From the 1993 ACT, the following efficiencies are provided;

    Cogeneration cycle: *75%*

    Combined cycle: *50%*

    Regenerative cycle *40%**

    Simple cycle: *35%*

CT Population Database

- Next Steps (Cont.):
  - Develop “Final Population Database”
  - Review potential subcategories

1992 Section 114 Data

- Summary
  - 4,051 turbines
  - 50 States + District of Columbia and Guam
  - Include facility information - Site name, location, & year
  - Include turbine information - Make, Model, #units, & ISO Rating

1992 Section 114 Data

- Summary
  - Include more records for 22 states